Name _____ AP Chemistry

Gas Stoichiometry

Scientists decided to agree upon common reference conditions, known as *standard temperature and pressure (STP)*. These values are 0°C or 273 K and 1 atm. If this gas is assumed to be an ideal gas and there is only one mole of the gas present, the volume is 22.4 L. This is known as the *molar volume*. Using STP and molar volumes, multiple calculations involving gases in a reaction can be performed.

Example #1:

A sample of nitrogen gas has a volume of 1.75 L at STP. How many moles of N_2 are present?

Example #2:

Quicklime (CaO) is produced by the thermal decomposition of calcium carbonate ($CaCO_3$). Calculate the volume of CO_2 at STP produced from the decomposition of 152 g $CaCO_3$ by the reaction:

$$CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$$

Another important aspect of ideal gases is determining the molar mass of the gas. Using the relationship between moles and molar mass along with the ideal gas law, the following equation can be used to calculate the molar mass of a gas:

Example #3:

The density of a gas was measured at 1.50 atm and 27°C and found to be 1.95 g/L. Calculate the molar mass of the gas.

Practice Problems:

1) Calculate the average molar mass of dry air if it has a density of 1.17 g/L at 21°C and 740.0 torr.

2) In the first step in the industrial process for making nitric acid, ammonia reacts with oxygen in the presence of a suitable catalyst to form nitric acid and water vapor:

$$4\ NH_3\ (g) + 5\ O_2\ (g) \rightarrow 4\ NO\ (g) + 6\ H_2O\ (g)$$

How many liters of NH_3 at 850°C and 5.00 atm are required to react with 1.00 mol of O_2 in this reaction?

3) A student adds 4.00 g of dry ice (solid CO_2) to an empty balloon. What will be the volume of the balloon at STP after all the dry ice sublimes (coverts to gaseous CO_2)?

4) Sulfur trioxide, SO_3, is produced in enormous quantities each year for use in the synthesis of sulfuric acid:

$$S\ (s) + O_2\ (g) \rightarrow SO_2\ (g)$$

$$2\ SO_2\ (g) + O_2\ (g) \rightarrow 2\ SO_3\ (g)$$

What volume of O_2 at 350°C and a pressure of 5.25 atm is needed to completely convert 5.00 g of sulfur to sulfur trioxide?

5) (a) Calculate the density of sulfur hexafluoride gas at 678 torr and 28°C.

(b) Calculate the molar mass of a vapor that has a density of 7.135 g/L at 12°C and 743 torr.